Air & Space CMMS
Project Overview

Air Force Domain Analysis Team
George Mason University
The Institute of Public Policy

July 18, 1996

Air & Space CMMS
Project Overview

- Background
- People
- Methodology
- Authoritative Sources
- Common Structure
- Common Syntax and Semantics
- Tools
- Process
- Validation
- Products

Air & Space CMMS Background

- Project period from July 1996 to April 97 (funding permitting)
  - Builds on previous work for ARPA and US Army CECOM
- Sponsored by Air Force Electronic Systems Center (ESC)
  - NASM funded AF domain analysis
  - Supports Joint CMMS
- Concepts and processes adopted by other programs
  - DMSO CMMS prototype
  - Army Functional Description of the Battlespace (FDB)

Air & Space CMMS
The Team

- Dr. Bob Might (Principal Investigator)
  - GMU Professor in Modeling and Simulation Analysis and Design
  - AF Systems Engineer
  - AF Studies and Analysis
    - Thunder and TAM models
  - NDU Studies and Analysis Center
- Mike Metz (Team Chief)
  - Tactical Operations
  - Army Air Liaison and FAC
  - CHECKMATE Team
    - Command and Control Analysis
    - Tactical nuclear and conventional weapons analysis
  - OSD Net Assessment
    - RSAS Model User Group Chairman
    - Research Director

Air & Space CMMS
The Team (continued)

- Martin Bredeck (Systems Engineer)
  - AF Studies and Analysis
  - Systems Engineer and Database Expert
  - Object-Oriented Analysis and Design
- Mike Cosgrove (Consultant)
  - Systems Engineer
  - Thunder model expert
- Rick Parker (Subject Matter Expert)
  - Tactical Fighter and SOF Operations
  - Command and Control Analysis
  - International Military Assistance

Air & Space CMMS Methodology

- Processes described by Domain/Subject Matter Experts in text narrative based on experience and authoritative sources
  - Doctrine traceability
- Processes captured in common structure with common syntax and semantics using systems engineering tool
- Products made available for review on WWW
  - At ESC, GMU/TIPP and IMC
- Validation process includes
  - Visits to Subject Matter Experts, other Command and Control analysts, and exercises (Blue Flag)
  - Seminars hosted at GMU
  - Not official VV&A validation
- Still evolving and improving
- Tied to ARPA, DMSO and converging baselines of other CMMS projects

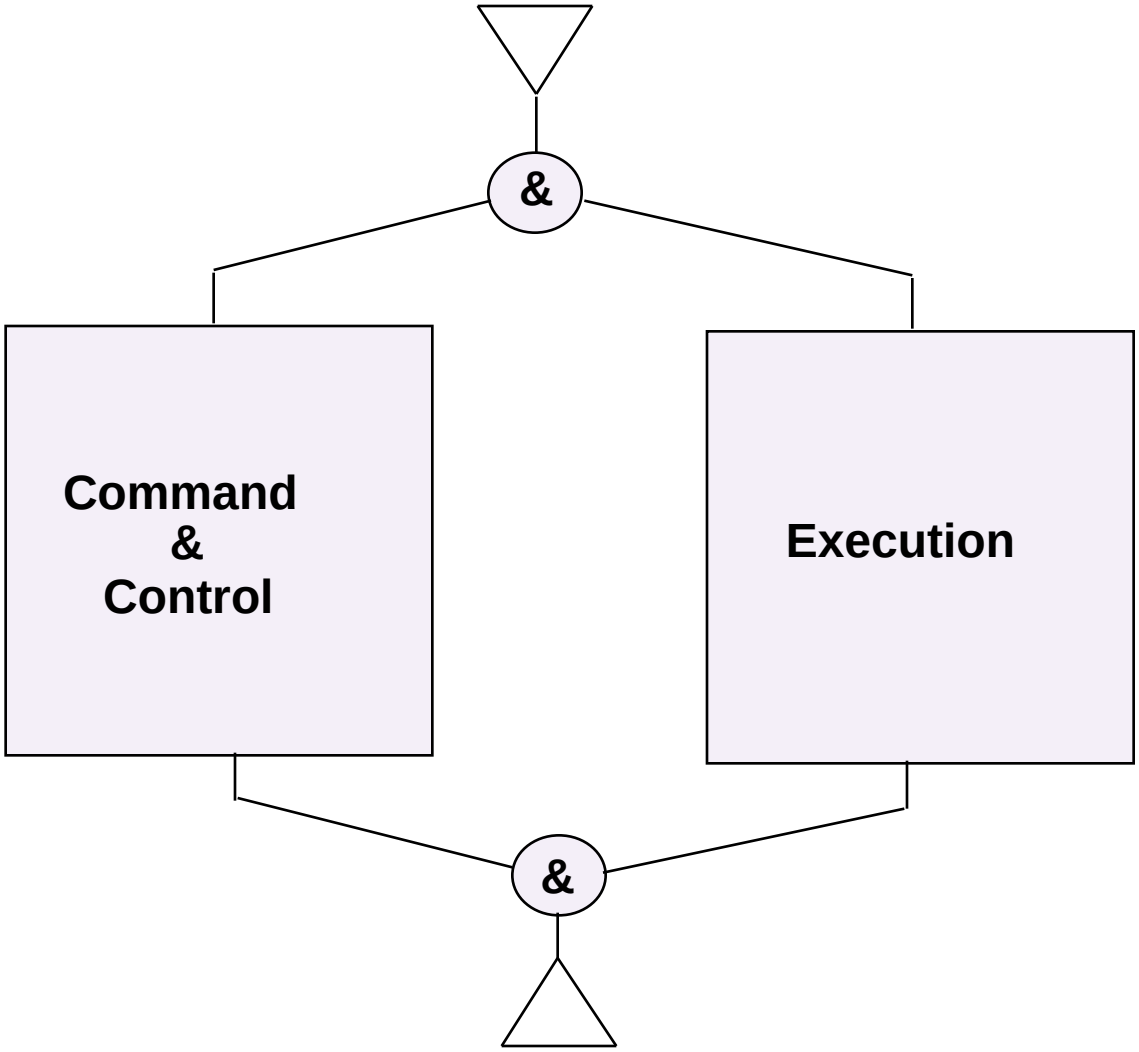
Air & Space CMMS
Examples of Authoritative Sources

- Joint Doctrine
  - JP 3-0 *Doctrine for Joint Operations*
  - JP 3-03 (Test) *Doctrine for Joint Interdiction Operations*
  - JP 3-56.1 *Command and Control for Joint Air Operations*
  - JP 3-09.3 *Joint Tactics, Techniques, and Procedures for Close Air Support*
- Service Doctrine
  - AFM 1-1 *Basic Aerospace Doctrine of the United States Air Force(Vols I and II)*
  - AFDD 30 *Airlift Operations*
- Service Publications
  - *AF/XO's JFACC Primer*
  - *ACCI 13-AOC Volume 3, Operational Procedures--Air Operations Center*

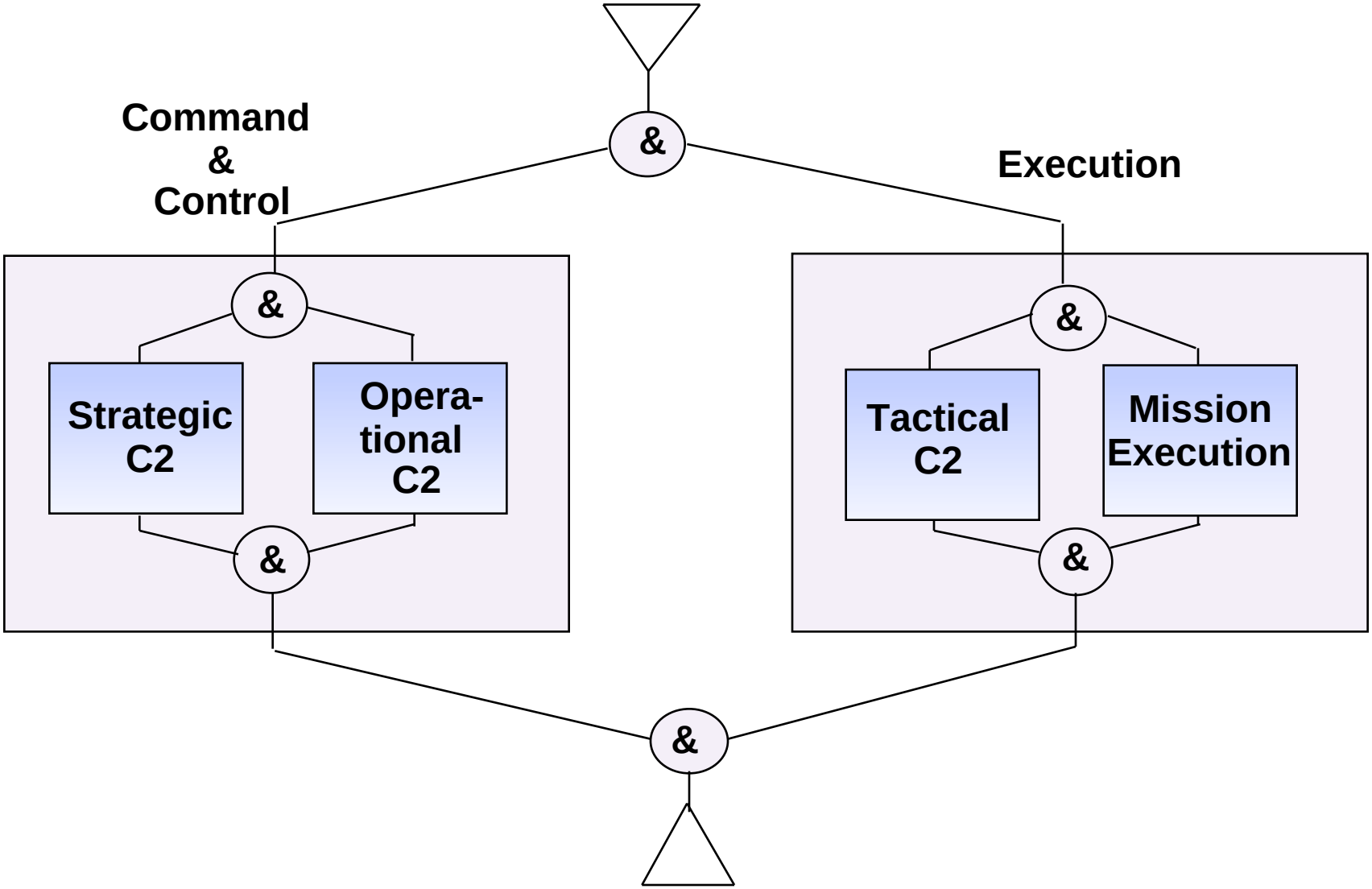
Air & Space CMMS
Common Structure

- Provides Framework for Multiple User Analysis
  - Conceptual Model for Simulation (CMODSIM)
  - Conceptual Model of Command and Control (CMODC2)
  - Conceptual Model for Simulation Execution (CMODSIMEX)
- Assists in Validation Process with Domain and Subject Matter Experts

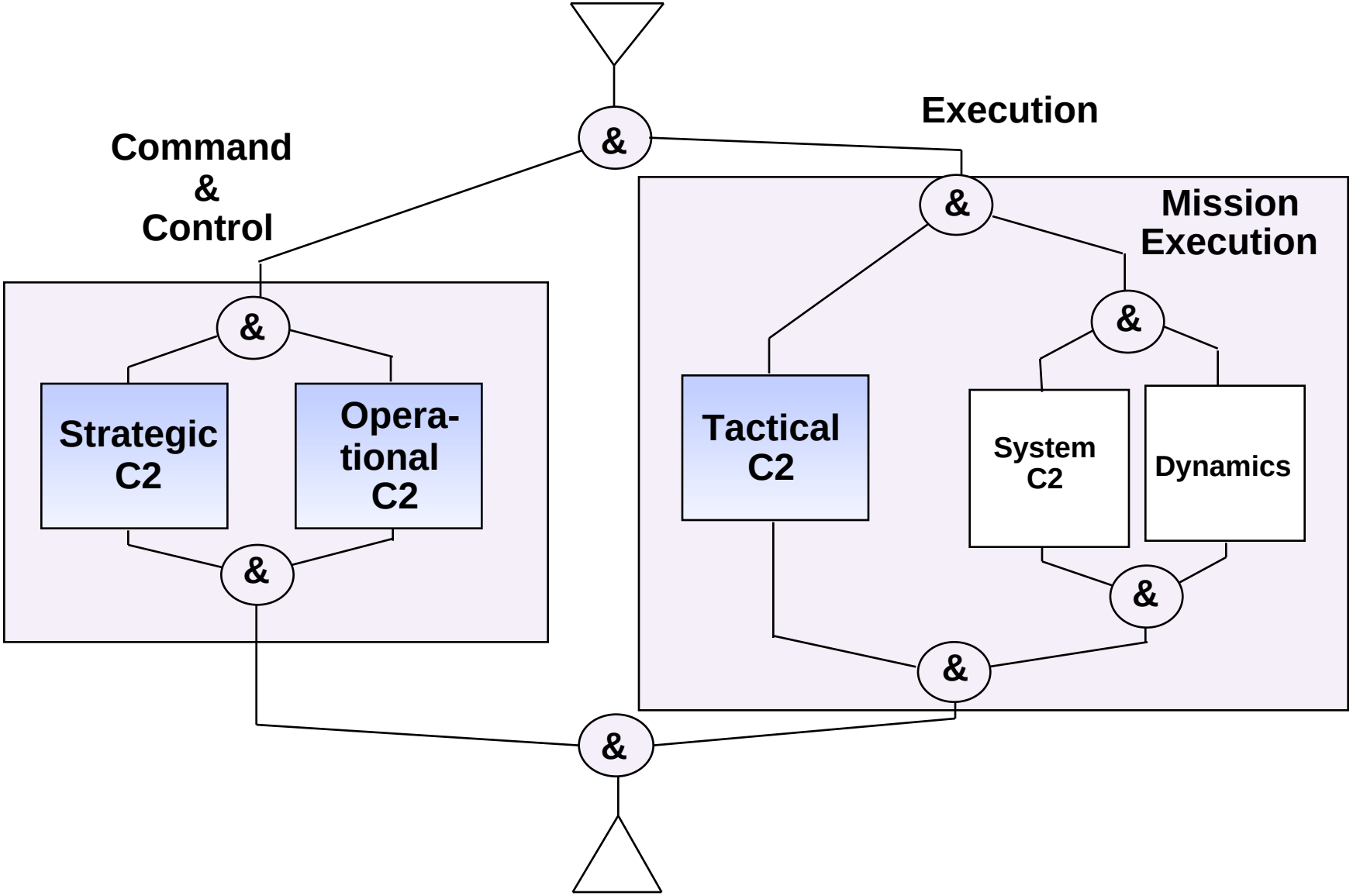
Air & Space CMMS
CMODSIM (level 0)



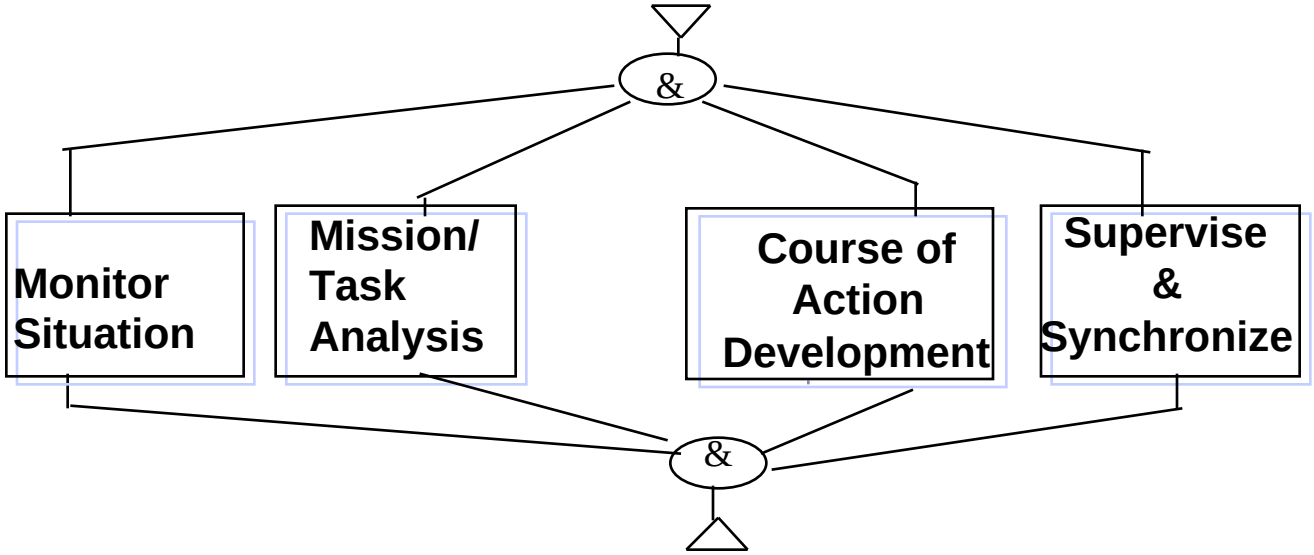
Air & Space CMMS
CMODSIM (level 1)



Air & Space CMMS
CMODSIM (level 2)



Air & Space CMMS
Common Structure
Conceptual Model of Command and Control
(CMODC2)



Air & Space CMMS
Common Syntax and Semantics

- Using common syntax and semantics provides process descriptions with greater validity
- Speeds integration and validation of diverse components developed by different teams
- Assists in validation process with DEs/SMEs
- Will foster automatic code generation

Air & Space CMMS
Systems Engineering Tool

- RDD-100
- Provides ERA behavioral database
  - Behavior Diagrams
  - IDEF0
  - Nsquared
  - DFD
  - Functional Block Diagrams
  - Real World Object Model
- Diagrams readability improves validation process
- Dynamically verifiable

Air & Space CMMS
Key Observations

- Combat Models and Simulations are a representation of highly coupled, **complex processes** that are performed by multiple, heterogeneous (yet interacting) systems
- The basic or core processes in combat are **relatively stable**
- The systems that make combat processes a reality are often **interchangeable** and **constantly changing**

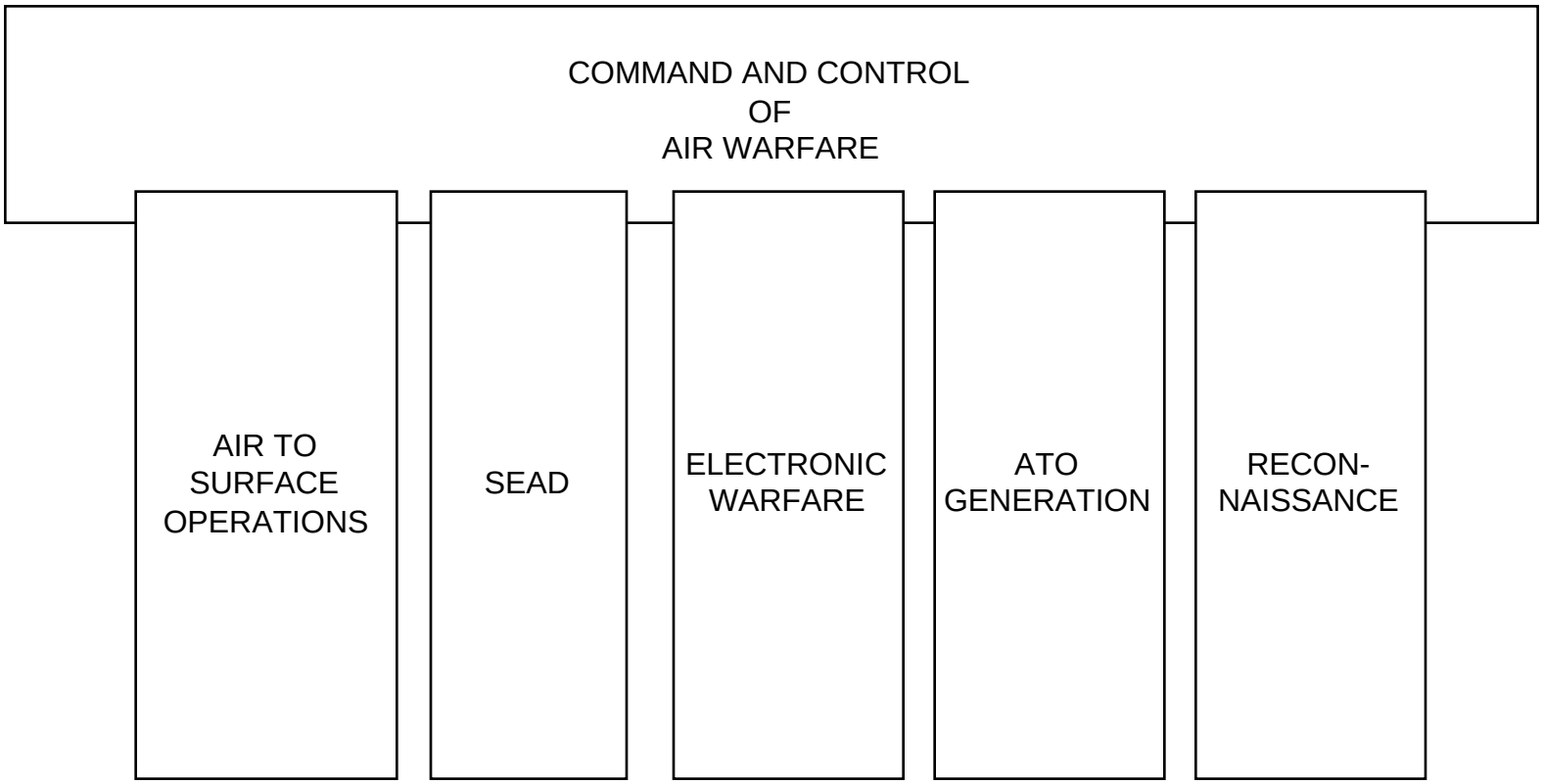
Conclusion

Conceptual Models of combat should focus on the combat processes -- letting these drive the object classification and object models

Air & Space CMMS
Conceptual Models

- Conceptual Models are the first abstraction of the real world:
  - they MUST facilitate communication between Subject Matter Experts (SMEs) and Simulation Developers
  - they MUST be simulation and simulation method independent (i.e. they must support the development of either process oriented or object oriented simulations)

Air & Space CMMS
Mission Space is comprised of Missions



Incrementally fill out the mission space until all AFM 1-1 missions are represented, including MOOTW

Air & Space CMMS
Added Value of Behavioral Database

- Enhanced user manuals
- Configuration management
- Model/Simulation V&V
- Simulation migration management

Air & Space CMMS Validation Process

- Products posted on ESC server, GMU/TIPP server, and IMC server for access in Adobe Acrobat .pdf format and Postscript format
  - ESC (www.NASM.hanscom.af.mil/NASM--password is 1rolex)
  - GMU/TIPP Homepage (ralph.gmu.edu)
  - IMC (ftp to kelly.imcva.com)
- Visits to Domain Experts and SMEs
  - ACC DO
  - ACC DR
  - Air Staff
- Exercises
  - Blue Flag
- Validation Seminars at GMU/TIPP

Air & Space CMMS
Validation Results to Date

- JFACC processes, with minor modification, represent activities of JFACC staff as practiced in Blue Flag exercise
  - Some SME face validation
  - Planned GMU validation seminar in Fall 96
- Tactical Airlift has been adjusted to meet requirements of ACC/DOOM (Tactical Airlift staff)
- Generic Mission and Air Interdiction validation process ongoing
  - Some SME face validation
  - Planned GMU validation seminars in Fall 96

Air & Space CMMS
Work Completed

- JFACC Processes
  - Interfaces with JFC and other components
  - Air Operations Center processes
  - ATO planning, production and execution
- Generic Mission Processes
  - Generic aspects of air missions
- Air Interdiction Mission Process
  - Specific air mission
  - Multiple views
    - Narrative Text , Behavior, and IDEF0 Activity
- Tactical Airlift Processes

Air & Space CMMS
Work In Progress

- Specific Air Missions
  - Air Interdiction Object View
  - CAS Text narrative view
- Integration of Command and Control with Specific Mission Processes and Tactical Airlift

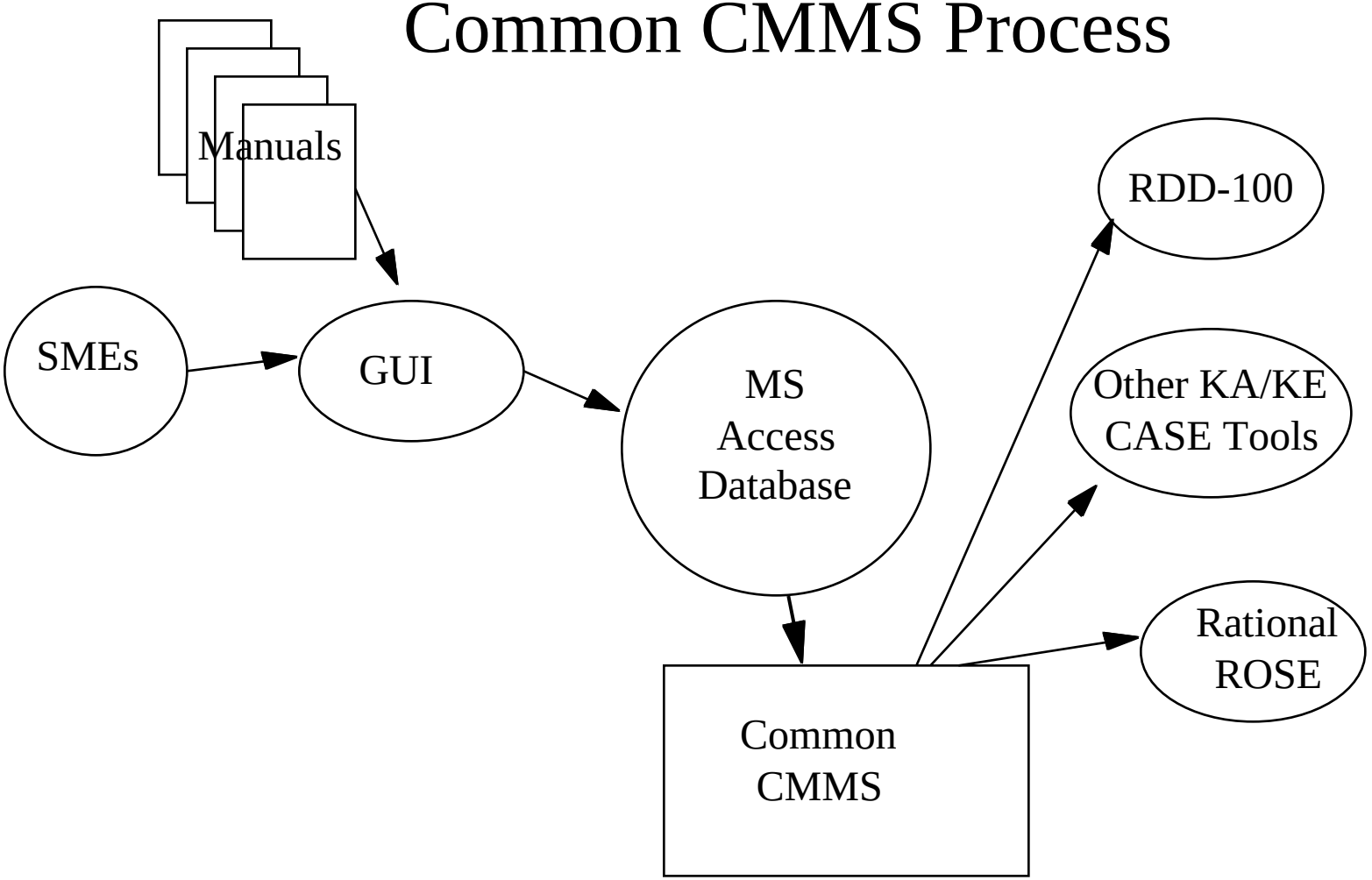
Air & Space CMMS
Work Planned

- Specific Air Missions
  - Electronic Warfare
  - Air Superiority
  - Tactical Reconnaissance
  - Remaining missions as schedule permits
- Total Integration
  - All specific air missions under theater operational air command and control structure
- Continue Informal Validation Process
  - Fall 96 seminar series at GMU

Air & Space CMMS
Other Activities

- Processes, methodology, semantics and syntax also being used for US Army's Functional Description of the Battlespace (FDB)
  - Army behavior database for FDB (IMC)
  - Task-Input-Output matrices
  - RDD-100 behavior diagrams
- DMSO CMMS Prototype
  - Developers using Air Interdiction products (developed at GMU and IMC) as air portion of joint interdiction example
  - DMSO CMMS common semantics/syntax (IMC)

Air & Space CMMS
Common CMMS Process

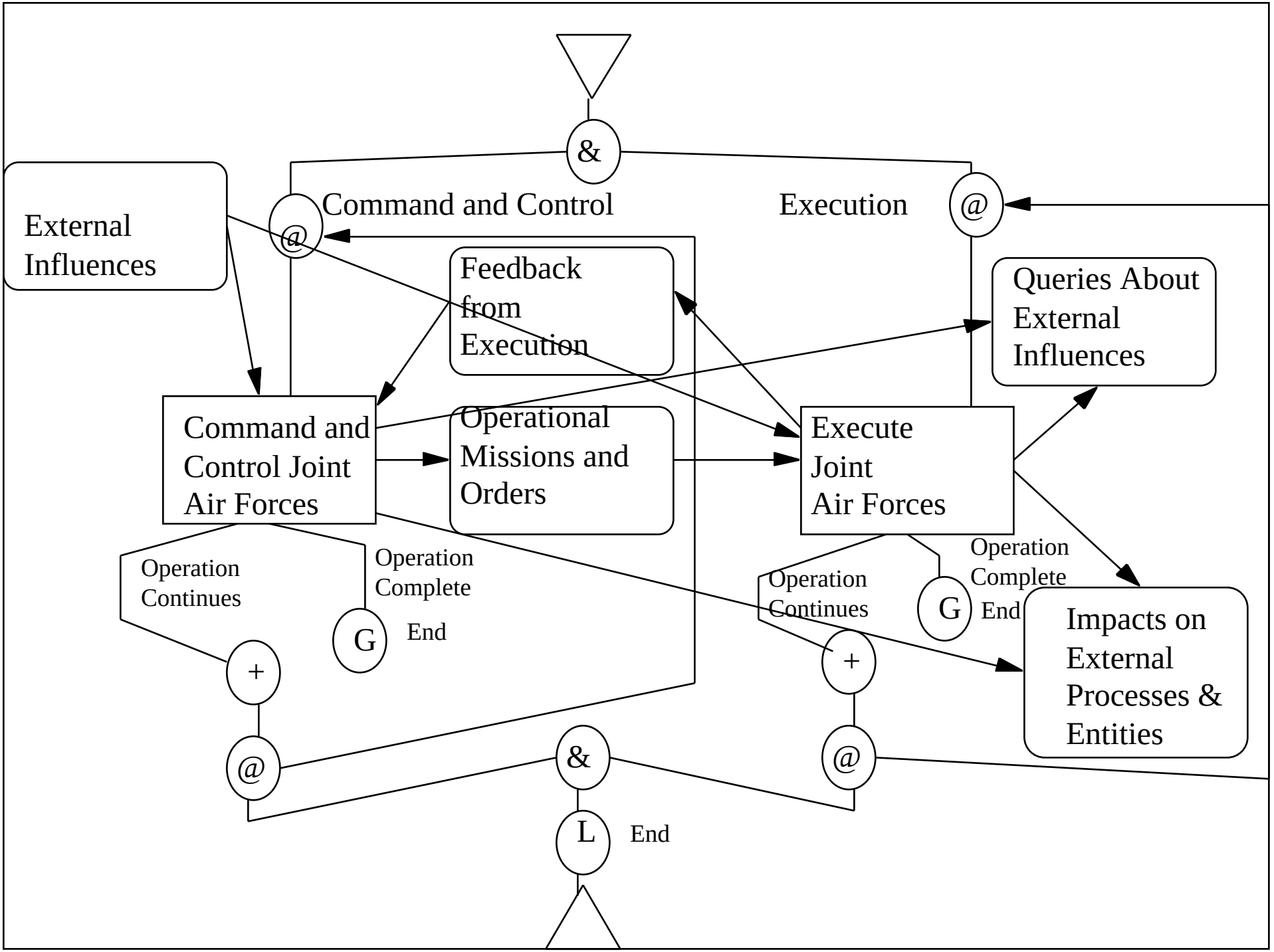


Backups Start Here

Air & Space CMMS
Air Force Domain Analysis

Describes behavior during air combat and combat support operations:

- Command and Control (Cognitive Processes)
  - Strategic
  - Theater or Operational
  - Tactical
  - System
- Execution (Physical Processes)
  - Communicate
  - Sense
  - Move
  - Engage


&
@
Command and Control
Execution
@
External Influences
Feedback from Execution
Queries About External Influences
Command and Control Joint Air Forces
Operational Missions and Orders
Execute Joint Air Forces
Operation Continues
Operation Complete
G
End
Operation Continues
Operation Complete
G
End
+
+
@
@
&
L
End
Impacts on External Processes & Entities

Air & Space CMMS

Illustrative Common Semantics for AF Domain Command and Control

- **Gather Information**
  - **-- Gather**
  - **-- Classify**
  - **-- Highlight**
  - **-- Find**
  - **-- Combine**
  - **-- Merge**
  - **-- Parse**
  - **-- Sort**
  - **-- Check**
  - **-- Receive**
  - **-- File**
  - **-- Catalogue**
- **Review/Assess Requirements and Resources**
  - **- Identify**
  - **- Determine**
  - **- Restate**
  - **- Prioritize**
  - **- Estimate**
  - **- Analyze**
  - **- Review**
  - **- Update**
  - **- Prepare**

Air & Space CMMS

Illustrative Common Semantics for AF Domain Command and Control

· Prepare Alternative Plans

- **Develop**
- **Recommend**
- **Process**
- **Array**
- **Detail**
- **Compare**
- **Examine**
- **Contrast**
- **Investigate**
- **Assess**
- **Integrate**
- **Plan**
- **Match**
- **Calculate**

· Direct Operations

- **Choose**
- **Command**
- **Evaluate**
- **Issue**
- **Implement**
- **Direct**
- **Redirect**
- **Allocate**
- **Apportion**
- **Assign**
- **Appoint**
- **Control**
- **Decide**
- **Secure**
- **Order**
- **Give**
- **Coordinate**
- **Approve**
- **Select**
- **Acquire**
- **Obtain**

Air & Space CMMS

Illustrative Common Semantics for AF Domain
Command and Control (Multiuse)

-- Screen
-- Integrate
-- Initiate
-- Determine
-- Restate
-- Determine
-- Identify
-- Study
-- Update

Air & Space CMMS

Illustrative Common Semantics for AF Domain

Dynamics

· Execute Combat

- Sense
--
--

- Move
--
--

- Engage
--
--

- Communicate
--
--

RDD-100's Current Object View

- **Support for Object Types is provided in multiple views**
  - **Object editing and browsing**
  - **Classification view**
  - **Composition view**
  - **Association view**
- **The Integrated System Model is developed in different perspectives, including ...**
  - **Real World Object perspective, specifying inheritance and processes**
  - **Behavior Model perspective, specifying external, observable behavior of processes**
- **Object are then used in different Integrated System Models**
- **RDD-100 handles the management of originating and derived requirements**

Ascent Logic's Plan for RDD-100's Object View

- An Object-Oriented System Engineering methodology that defines the system (or process) as a collection of collaborating (interacting) objects that achieve a common purpose
- Uses "Best of Class" OO representation:
    - Rumbaugh's Object Structure notation
    - Jacobson's Use Case representation to behavior
    - Odell's representation for information engineering
- Commitment to support the leading industry methodology as the market demands it
- Currently found to be extremely compatible with the Unified Method
- Fundamentally based on OO database management; capable of evolution consistent with this paradigm

Examples of Object Classes in the Unified Method

Generic Air Mission Object Inheritance Diagram